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AGRICULTURAL MEMORANDUM NO 591

Prospects for silage maize in the North of England

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1. INTRODUCTION

Maize is a warm-climate crop and at first sight not a promising one for the North of England. Grain production is not in question, but in favourable circumstances the green plants with partially-ripened cobs can produce a heavy crop of nutritious fodder, suitable for zero-grazing or silage. The yield of dry matter per acre may not exceed that of well managed grassland, but it can be taken at one cut, and at a time when grass harvesting is over. Many enquiries are being received about the prospects for the crop in Northern areas. Partly this is because the seed is being pushed by a commercial organisation, but the increased cost of bought-in concentrates for winter feeding of cattle is also an important factor. The maize crop (in contrast to grass) may be a complete failure, and the farmers involved are already economically hard-pressed. Therefore it is important that good advice should be given on the climatic requirements for success.

2. SOIL TEMPERATURE

There is a massive literature on the climatic requirements of maize, mostly applicable to warmer regions. Ag Memos 332, 341, 346, 353 and 480 by Dr M Hough, with their bibliographies, give an indication.

For free germination, soil temperatures around 10°C (50°F) are needed. One suggestion is that soil temperature at 5 cm depth should exceed 10°C for one week before sowing takes place. This would give some insurance against a later cold snap, and ensure rapid germination, minimising losses by birds eating the seed. In the Vale of York and lowland Lancashire, these conditions generally occur in the first half of May, which is the commercially accepted sowing date in the region.

3. AIR TEMPERATURE - ACCUMULATED DEGREE-DAYS

The effect of air temperature on the crop is more controversial. One commonly used measure is accumulated degree-days above 10°C (50°F), from the date of sowing. The threshold of 10°C (4-5°C higher than for grass) takes account of the crop's requirement for warmth before growth will start.

The calculation of degree-days causes some confusion, because different workers have done it in different ways, so that the seasonal totals for their sites are not strictly comparable.

If a day has a maximum temperature of 18°C and a minimum of 12°C, mean temperature 15°C, it will contribute 15-10=5 units to the accumulated total. If however the maximum is 23°C and the minimum 7°C, part of the day has been below the threshold of 10°C. Although the mean is still 15°C, the contribution to the degree-days is now ~~less~~ more than 5, by an amount depending on the hour-by-hour temperature variation. By making some plausible assumptions about the shape of the variation, and using the maximum and minimum temperatures separately, this can be allowed for. The method is given in Met O Leaflet No 10, and the calculation may be done by tables or by formula, as most convenient. To some, this method is known as "the Agro-met method", and the accumulated °C days as "heat units".

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Compared with the use of daily mean temperature, the use of daily maximum and minimum is a considerable improvement, However, even when the temperature falls way below 10°C, perhaps to freezing point or lower, the contribution to the accumulated °C days stays at zero. That is, no account is taken of the negative effect which really low temperatures may have in checking the growth of a tender crop.

Often daily maximum and minimum temperatures are not available, or the labour of processing them is excessive. Then a short-cut method due to Thom may be employed, which uses the monthly mean temperature of the particular year, and the standard deviation of monthly mean temperature over a period of years at the site. The latter quantity varies little from place to place, and may be read with sufficient accuracy from maps given by Shellard in Met Office Professional Note No 125. Shellard also gives graphs for degree F days below 60°F, but his method has been used by Harvey in Ag Mem 527 to produce similar curves for degree F days above 50°F (10°C). Results using these curves agree closely with those obtained using Met O Leaflet No 10 (the "Agro-Met method").

For this paper, values of degree days have all been produced using monthly mean temperatures, Shellard's maps of standard deviation of monthly mean temperature, and Harvey's curves.

4. AIR TEMPERATURE - MORE COMPLICATED MODELS

The use of accumulated degree-days assumes that growth of the crop increases linearly with increase of temperature above the threshold. More complicated models are possible, using terms in T^2 as well as T, and treating maximum and minimum temperatures separately, with different coefficients.

One such model which has attracted attention is that of Brown in Ontario. Growth is assumed to proceed slowly from a minimum temperature of 40°F, more rapidly when the maximum is above 50°F, to reach a peak at 86°F, and to decline at still higher temperatures.

It seems unlikely that the reduced response at very high temperatures is important in the North, since these temperatures are reached so seldom. Growth with minima down to 40°F is perhaps a more open question. In the rest of this paper, accumulated °C days above 10°C will be used exclusively. Though this measure does not by any means tell us everything about the effect of weather on maize, the agronomic data available at present do not justify the use of a more complicated model.

5. DEGREE-DAY REQUIREMENTS

Dr M Hough gave minimum values of accumulated temperatures necessary for a successful crop, based on his analysis of trials at Oxford with the variety Inra 200. More recently Dr S Bunting of the Plant Breeding Institute at Cambridge has suggested other values, based on wider experience with the crop (Bunting 1973). Dr Bunting is more optimistic for silage and less for grain than Dr Hough. Their ideas are summarised in table 1.

TABLE 1 Accumulated °C days above 10°C from sowing to harvest, required to bring maize to different stages of maturity.

	Hough	Bunting
for silage	628	550
for grain	662	750

The maize growing season is May-October approximately, and it is generally agreed that the year-to-year variability of warmth can be represented by a value of 80°C days for the standard deviation of accumulated temperature over the five months, in all likely maize growing areas in the UK. It might be desirable to look at this figure again for marginal areas, but for the present it will be accepted. By using it with tables of the Normal curve, chances of success (years in 10) can be estimated.

Average accumulated temperatures and chances of success with silage on Hough's and on Bunting's criteria are shown in table 2. The averages are for 1931-60, except for Cawood and High Mowthorpe, which were supplied by Dr Hough and are for 1950-70. Also given are the values attained in 1972 (a poor year for maize) and 1973 (a good year) at some of the stations.

TABLE 2 Accumulated °C days May-October, and chances of successful silage maize on two criteria.

Station	Height (ft) above MSL	Average acc °C days	Years in 10 for success		acc° C days	
			Hough	Bunting	1972	1973
Berwick	76	459	0.2	1		
Cockle Park	325	459	0.2	1		
Durham	336	568	2	6		
Catterick	175	601	4	7½		
Croft	(150)	687	7½	9½	465	611
Scarborough	168	681	7½	9½	465	611
Hull	8	786	9¾	10	616	772
High Mowthorpe	574	500	½	2½	388	484
Cawood	18	643	6	9	510	673
Kirkham	89	629	5	8½	478	699
Newton Rigg	560	516	1	3		
Carlisle	114	614	4	8	477	618

Information on performance of the field is limited as yet, though in 1973 useful surveys of commercial crops were made in Lancashire and the North Riding of Yorkshire. It was generally agreed that 1972 was a poor year for maize. The writer saw the High Mowthorpe (Yorkshire Wolds) crop in November, when it was barely knee-high and very sparse. Under 400°C days therefore, is likely to be an outright failure. In favoured lowland areas in the Fylde (represented by Kirkham), Vale of York (Cawood) and Holderness (Hull, Scarborough), crops were harvested. Yields and dry matter were low, but some tolerable silage was made. These crops had 450-500°C days. The same comment would apply to the High Mowthorpe crop in 1973, which had 484 °C days.

1973 was a good year for maize. Satisfactory crops for silage were obtained in all the lowland areas, and it was reported that in the Vale of York (Cawood, 673°C days) near-combinable grain was obtained in some cases.

By piecing this data together, table 3 has been compiled.

TABLE 3 Tentative scheme for response of maize to temperature in Northern England.

Accumulated °C days May-Oct	Response
Less than 400	Crop fails
400-450	Poor crop
450-500	Tolerable crop
500-600	? (no field data)
600-700	Good crop
more than 700	Grain harvest possible

It will be noticed that there is a shortage of information in the range 500-600 acc °C days, and this makes it difficult to decide whether Hough's or Bunting's figure for silage (table 1) is better. The indications are that Dr Bunting is nearer the mark. An opportunity was missed in 1973, to resolve this by monitoring crops when 500-600 °C days had been accumulated, which in lowland Lancashire and Yorkshire would have been in late August. The suggestion about grain is based on one observation, and is only of academic interest in the Region.

6. EFFECT OF LOCAL CLIMATE

It is evident that with maize, any small increase in temperature is well worth having. A sheltered site with a sunny aspect should be chosen if possible.

7. EFFECT OF FROST ON THE MATURING CROP

Opinions differ on this. It has been suggested that autumn frost will halt the increase in dry matter, but that ripening will continue. On the other hand it was reported from Lancashire in 1973, that a sharp frost on 1 October brought some crops to a standstill. No doubt the severity of the frost and state of maturity of the crop when it occurs, have an influence.

8. SUITABLE AREAS

On the basis of our present sketchy knowledge, the following areas are suggested as climatically suitable. It is assumed that Dr Bunting's criterion is about right, and that failure must not occur more often than 1 year in 10 or so:

a. The Fylde district of Lancashire
b. The Vale of York, with some extension northward into the southern arable areas of the North Riding.
c. The Holderness district of the East Riding
d. Around Carlisle and up the Eden Valley

Climate is a controlling factor in success, but by no means the only one. Soil, weed control, and ability of the farmer to give the crop priority treatment, are also important.

Maize in the North will always be a marginal crop, and therefore it should not be recommended to any farmer whose climate or soil is dubious, or who is in an weak position economically.

9. FURTHER WORK

Our knowledge is very sketchy at present, and monitoring of crops of different varieties in different years is required. This should include monitoring of the progress of the crop through the season, so that in a good year we may infer behaviour in a moderate or poor year also. The effect of autumn frost also needs study.

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